EXPERT REPORT

BY

BILLY R. CLAY MS, DVM, DABVT

FOR
The Defendants in the:

STATE OF OKLAHOMA, ex rel, W. A. DREW EDMONDSON, in his capacity as ATTORNEY GENERAL OF THE STATE OF OKLAHOMA, and OKLAHOMA SECRETARY OF THE ENVIRONMENT C. MILES TOLBERT, in his capacity as the TRUSTEE FOR NATURAL RESOURCES FOR THE STATE OF OKLAHOMA,

Plaintiff

VS.

TYSON FOODS, INC., TYSON POULTRY, INC., TYSON CHICKEN, INC., COBB-VANTRESS, INC., CAL-MAINE FOODS, INC. CAL-MAINE FARMS, INC., CARGILL, INC., CARGILL TURKEY PRODUCTION, LLC, GEORGE'S, INC., GEORGE'S FARMS, INC., PETERSON FARMS, INC., SIMMONS FOODS, INC. AND WILLOWBROOK FOODS, INC.,

Defendants

CASE NO. 05-CV-0329 GKF-SAJ.
IN THE U.S. DISTRICT COURT, NORTHERN DISTRICT OF OKLAHOMA

November 29, 2008

Billy R. Clay MS, DVM, DABVT

Exhibit A

EXPERT REPORT

BILLY R. CLAY MS, DVM, DABVT
Veterinary Toxicologist and Agronomist

VI. QUALIFICATIONS

VI. COURT CASES WITHIN THE PAST FOUR YEARS

RATE: $190/hour plus expenses

EXPERT REPORT OF DR. BILLY R. CLAY

I. BACKGROUND

The Illinois River Watershed (IRW) has been a point of contention between the states of Oklahoma and Arkansas since the river was designated as a Scenic River by Oklahoma in 1969. There have been numerous agreements and disagreements since that date--all related to the quality of water flowing into Tenkiller Ferry Reservoir. The focus has been on the "ballooning" population of people and the agricultural activities that exist there. The current issue is focused on the poultry industry as the potential source of impairment for the river while excluding numerous other sources. The claim is that application of poultry litter to farm crops poses a threat due to bacteria and other substances from poultry manure that might enter the river where people play during the summer months and obtain water for household use.

II. OPINIONS

1. Poultry litter like other livestock manures and associated beddings has a long history of safe usage as an important source of fertilizer for human food production.

2. There are a variety of benefits associated with the use of poultry litter fertilizer and its application is highly regulated in the IRW.

3. Approximately 65 % of the land area of the IRW is devoted to farming (agricultural production).

4. Poultry production is one of seven primary farming enterprises that exist in the IRW.

5. Cattle production makes use of most of the land area devoted to farming enterprises. About 75 % of the farms produce beef cattle.

6. Fertilization of pastures and crops within the IRW is dependent upon availability and cost effectiveness of organic (animal manures) and inorganic fertilizer materials.

7. There are numerous sources of animal and human fecal material and its associated bacteria in this watershed.

8. Cattle spend nearly half the time in and near riparian areas while wildlife spend even more time there. The streams serve as the water supply for some of the livestock and most of the wildlife adding to stream-bank erosion and direct deposition of fecal material.

9. Cattle wet manure **production** in the IRW represents about 61 % of the total animal manure while poultry is about 25 % of the total. Cattle manure is deposited directly to the land surface while poultry manure is deposited on an organic matrix in the poultry house and is allowed to undergo drying and fermentation before it is available for land application as fertilizer or export.

10. Fecal bacteria are present in wet (hydrated) manure but die as they are exposed to drying and sunlight.

11. Poultry litter, swine lagoon contents and composted dairy cattle manure contains less dry weight and fecal indicator bacteria than fresh manure. After fermentation and drying poultry manure as litter represents approximately 11 percent of the total produced while cattle manure represents about 77 percent. Fecal *coliform* bacteria content in poultry litter manure is reduced to about 6 percent of the total at the time of harvest while cattle production represents about 90 percent of the total produced at that point.

12. Cattle, horses and wildlife concentrate manure within or near the riparian areas and some manure is deposited directly into streams.

13. Poultry litter produced in the IRW annually has been estimated within a range of 231,000 to 354,000 tons. A middle (near average) estimate is about 295,000 tons.

14. At least 70,000 tons of poultry litter is currently exported annually from the IRW, 23,600 tons are carried over to the next production cycle and 18,000 tons are stored before usage.

15. Of the phosphorus (P) in livestock and wildlife manure produced in the IRW, cattle contribute about 46 percent of the total that is directly deposited on the fields and in the riparian areas while poultry litter available for application represents about 35 percent of that total and it is not applied to the riparian areas.

16. Laws and regulations are in place to govern poultry litter usage as fertilizer. The state has produced no evidence that cattle producers in the IRW have violated the laws and regulations pertaining to the application of poultry litter.

17. There are more than 11,000 property owners in the IRW with 5 acres, or more, but only about 4,500 identify themselves as being engaged in farming. The remaining 6,500 non-farmers have little regulatory oversight relative to the way they manage their properties. Only 1,580 per year have submitted soil samples for assay over the past three years.

18. Confinement poultry businesses are highly regulated by the EPA, FDA and USDA with additional state oversight. For EPA purposes they are identified as AFOs (animal feeding operations) or CAFO's (confined animal feeding operations).

19. There is no evidence that because of the use of antibiotics in poultry production there are concomitantly resistant pathogenic bacteria in the waters of the IRW.

20. The presence of steroid hormones in surface waters in the IRW in parts per billion or trillion concentrations does not suggest that poultry are the source. Hormones are not used as growth promotants in poultry production and all animals, birds, and humans produce and excrete hormones.

III. BASIS AND REASONS FOR EACH OPINION

A CHARACTERIZATION OF POULTRY LITTER (Opinions 1-2)

Poultry litter is a mixture of organic material (wood shavings, saw dust, crop residues, etc.), the collected poultry excrement, spilled feed and water. The duration of a typical litter cycle is 1 to 2 years. In the case of broiler production new organic material is applied to a depth of four to six inches (10 to 15 tons) to the cleaned and disinfected floor of a chicken house which will house about 20,000 broilers. New broiler chicks are added to the environmentally controlled barn where they will grow and develop over a period of six to seven weeks. During that time at least three different ration formulations will be provided that become a part of the excrement, etc. that is deposited on and in the organic material to produce litter. The organic material serves as an insulating absorbent and adsorbent medium to help keep the chickens dry and comfortable. Poultry growers regulate the air flow and temperature so that the litter is dried to a target moisture content of near 20 percent (broiler manure is excreted at approximately 75 percent moisture). Because chickens tend to congregate near feed troughs and water dispensers, that area of the litter may become "caked" by week six and possess moisture in excess of 20 percent (Poultry Waste Management Handbook 2000 and Agricultural Waste Management Field Handbook 1992 and Shaffer 2005).

When the broilers are removed from the house the grower will de-cake the litter and add a thin surface layer (two or more inches) of fresh organic material prior to the next group of chickens. This process is continued for five to several turns of broilers and the house is then thoroughly cleaned and disinfected. The harvested litter at clean-out is about 25 percent moisture and weighs 100 to 125 tons. The de-cake material may be up to 35 percent moisture and weighs 10 to 15 tons. Not all producers follow an annual cycle-about 8 percent will clean-out the houses after two or more years (Fisk 2008). All litter undergoes some fermentation (composting effect) and loss of dry matter through microbial degradation and assimilation. The amount of microbial assimilation depends on the time in the house and/or in storage. The drying and fermentation processes alter the composition of the microbial population from that of fresh manure (Kelley 1994 and Lu 2003).

Breeder, layer, pullet, cornish hen and turkey production involves different production cycles but where litter is used on the floors similar processes may follow resulting in a varying constituency of the end product at the time of cleaning of the houses.

The litter cake and litter may be stored or applied directly to agricultural land according to a nutrient management plan to which each farmer must adhere. Most litter is stored, exported or applied at or near the time of removal from the poultry house. That applied is not necessarily on the same fields, annually. Not all the litter produced on a particular farm will be applied to that farmer's land. Some will be sold to other farmers or business entities in the area or shipped outside the area. Some poultry producers do not have sufficient acres of farmland to generate a need for their total production of litter. Therefore some or all of their litter is stored, or sold to others who must also apply it according to the regulations of the respective states. There are laws in place in both Oklahoma and Arkansas to regulate the surface application of poultry litter. The guidelines set forth will dictate the amount of litter that a given parcel of land can receive, as well as, identify parcels of land that should not have poultry litter applied.

HISTORY AND VALUE

Animal bedding with excrement fertilizer is not unique to the poultry industry. As long ago as 300 BC Theophrastus recognized and recommended the use of animal bedding as further enrichment for the soil. In that period the focus was on donkeys, sheep, goats and cattle. Similar recordings were made in China over 2,000 years ago. The Greeks perfected the use of such fertilizers in their soils and the Romans adopted their practices. In fact some of the Roman intellectuals took the collection of fertilizer to another level by digging pits near farm buildings for systematic collection of various wastes including animal, fowl and human along with leaves, vegetables and virtually all other organic materials they could find. In the 16th and 17th centuries manure with bedding fertilizer was traded as commercial fertilizer is today.

Mineral fertilizer amendments were discovered and began to be used during that same period. The extensive experimentation and utilization of mineral fertilizers that followed paved the way for an expanding population and the concentration of populations within cities. However their use did not replace organic fertilizers such as poultry litter. Additional experimentation served to demonstrate the augmentation value of organic and inorganic mineral additions for prolific plant growth (Tisdale 1956, Millar 1958, The Gale Group, Inc. 2003).

Today we continue to use animal manure fertilizers wherever they are available. The composition of manures vary with animal species, feed source, and type of bedding used. Broiler litter typically contains 55 to 75 pounds of nitrogen per ton, 60 to 80 pounds of phosphate, 40 to 50 pounds of potash and 40 to 60 pounds of calcium. It will also contain 20 to 40 percent moisture and measurable quantities of magnesium, sulfur, sodium, chloride, iron, manganese, boron, zinc, copper and other micronutrients, as well as, any additives provided in the feed or added to the litter. Its value based on nutrient content alone (N, P_2O_5 and K_2O) when compared to current inorganic fertilizer prices is in the range of $110 to $140 per ton (National Agricultural Statistics Service 2008). The added intrinsic value of litter is that the decaying organic matter adds water holding capacity to the soil and the nutrients are more slowly released as the material decays during the growing seasons (Zhang 2002, Mullins 2002, Mitchell 1995, Zublena 1997, Vest 2004). The added water holding capacity allows crop plants to survive during periods of low rainfall and flourish during periods of adequate rainfall. The responsive growth of vegetation serves well to minimize erosion of surface soils.

Commercial inorganic fertilizers tend to be acidifying to soils. This is an undesirable trait in soils typical of the IRW. Those soils are acid prone and require the addition of lime periodically for maximum production. Poultry litter does not contribute in the same way to the acidity and it provides the additional intrinsic calcium and magnesium to further aid in acid neutralization (Zhang 1998). Likewise, poultry litter offers less soluble phosphorus for transport during excessive rainfall events (Edwards et al. 1994, Franklin et al. 2005 and Gaudreau et al. 2002).

In a ten-year study conducted by the US Department of Agriculture-Agricultural Research Service (Sainju 2007) the organic matrix of poultry litter increased soil carbon storage and microbial biomass and activity compared to inorganic fertilization. The advantage existed regardless of the cropping system (tilled with litter vs. no-till with litter applied to the surface). The conclusion was that carbon becomes sequestered in the soil surface which helps to offset atmospheric carbon dioxide and improve soil and environmental quality. For all the reasons cited above poultry litter serves as a valuable soil amendment as well as fertilizer source.

The increased demand for organic and/or natural food products has added another dimension of value to poultry and other farm animal manures. Products that carry the organic label must be grown in or on soils using fertilizers from an organic source. This market offers another opportunity for the small farming enterprise to remain profitable. Several organic food production farms exist in the region of the IRW where beef, vegetable, fruit and other farms are in operation (Kerr Center 2006 and Organic Resource Guide 2006).

AGRICULTURAL PRACTICES IN THE IRW
(Opinions 3 through 8)

The IRW consists of approximately 1.1 million acres of land most of which is used for agricultural purposes. Using the 2002 National Agricultural Statistics Service (NASS) census data provided at the county and zip code levels, the farm acres were calculated to be 698,525- about 65 percent of the total. Four thousand four hundred eight-two farms reported for that year (Appendix A, Table A-B and Appendix B). Approximately, 6,525 additional property owners of 5 acres, or greater, were not included in that summary and did not report the use of their acreage to NASS (Appendix I). The bulk of the land on the reported farms is devoted to cattle production (565,000 acres). Approximately 199,000 cattle were present in the watershed at the time of the 2002 census. Of that total 10,829 were dairy cattle. Hog, sheep, horse and miscellaneous animal and crop farms also exist. In addition, at least 3 commercial plant nurseries exist in the IRW.

Poultry farms are in higher concentration on the Arkansas side of the watershed (463 versus 140 on the Oklahoma side) while farm acreage is more closely divided with 53.3 percent in AR and 46.7 in OK. The predominant bird type produced is broilers with layers, breeders and turkeys following in that order. The average farm has approximately 3 houses in active production for a total of 1,809 houses (Appendix B, OCC 1999 and 2007). Litter from the houses serves as an important source of fertilizer for the farms in the IRW as well as those outside the watershed (U. of AR and OSU Cooperative Extension Ser.). The Oklahoma Conservation Commission (OCC) report dated September 2007 showed litter removal was fairly consistent on a monthly basis throughout much of the year with the higher amounts June through November and lower amounts December through May.

The bulk of the farm land is planted to permanent pasture or hay (334,228 acres). In addition there are 157,048 acres in which forage is grown for cattle (mostly no-till) and 74,368 acres of woodlands that are used as pasture. Approximately, 2,500 acres are devoted to the production of wheat, corn and soybeans. Those proportions are shown below:

Crop/pasture	Acres
Permanent pasture/cattle	184,411
Hay/harvested forage	149,817
Forage for grazing	157,048
Woodland pastures	74,368
Soybeans	1,960
Corn	354
Wheat	206
Total	568,164

At least 494,000 acres of farm land shown above is readily available for equipment access for farming. There is an additional 130,000 acres (mostly in small tracts) devoted to truck farming, nurseries, orchards, poultry houses, horses, swine, sheep and goats and other specialty farming. Some of that acreage would also be accessible to farm equipment.

Beef cattle production in the IRW involves a cow/calf year around system in which the primary product is the produced calf that is marketed in the fall of the year. At the time of the census (January) the cattle herd consists of brood cows, bulls, replacement heifers, carried-over calf crop (including fall calves and dairy calves) and purchased cattle. From February to November the current-year calf crop is produced and sold. There are a few fall calving producers but they are in the minority (county agents and area specialists).

Permanent pastures and most of the hay include bermudagrass and fescue. Seeded forages include cool season grasses (wheat, rye, ryegrass, etc) and summer forages such as sudangrass, millet and others. Most of the permanent pastures are over-seeded with legumes such as clovers (cool season) and lespedezas (warm season). Hay is harvested from all of the forages mentioned. The 47 inches of annual rainfall provide adequate moisture for both the cool and warm season forages to produce maximally if the other required nutrients are available (nitrogen, phosphorus, potassium, calcium, magnesium, sulfur and micronutrients). The other nutrients are provided in the form of animal manures and/or inorganic fertilizers. Poultry litter, dairy manure (partially composted) and swine lagoon effluent include the bulk of animal manures (organic) applied while urea, anhydrous ammonia, ammonium nitrate and mixed analysis fertilizers represent the inorganic fertilizers (Appendix A and E). The cool season forages benefit most from fertilization in the late summer to fall while the warm season forages benefit more from fertilization during the spring. Rainfall is fairly evenly distributed during the months of March through December at about 3.77 inches per month with lower amounts during January and February as shown below:

Historical Average Rainfall in inches at Three Gauging Stations in the IRW*

Station	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Tahlequah	2.38	2.44	4.15	4.08	5.66	5.19	3.48	3.23	5.35	4.33	4.65	3.20
Siloam Spr.	2.27	2.09	4.32	4.31	5.20	4.84	3.54	3.35	5.05	3.68	4.82	3.42
Prairie Grove	2.14	2.41	4.17	4.33	5.06	5.26	3.14	3.00	4.83	3.74	4.74	3.20
Average	2.26	2.31	4.21	4.24	5.31	5.10	3.39	3.19	5.08	3.92	4.74	3.27

*www.weather.com 50-year average

Because most of the pastures and forages exist as permanent or no-till, most of the fertilizers are applied to the surface. Nutrient applications are governed by the laws set forth in the respective states and the nutrient management plans for each property. Fifty (ephemeral streams) to one hundred-foot (permanent streams) buffer zones exist where application is prohibited in the vicinity of streams, buildings, wells, sinkholes, etc. Where vegetative filter strips are installed the buffer zone may be reduced to 30 feet. Likewise, application is limited or prohibited in areas of excessive slope, shallow-rocky soils, frozen, saturated or flood-prone ground or during times of anticipated precipitation (Oklahoma statutes Title 2 and Arkansas statutes Title XXII).

The grazing cycle of beef cattle is 9 to 10 months with hay and/or supplemental protein provided during the winter months (3 to 4). Salt and mineral mixes are provided free-choice continuously. Pastures are situated such that most cattle have access to riparian areas, flowing and/or non-flowing (ephemeral) streams (OCC 1999). In many cases the flowing streams serve as the permanent water supply while in others farm ponds serve as the source of water (OCC 1999, personal observation and Appendix K).

Cattle spend 8 to 12 hours per day grazing depending on the available forage (Funston 1991, Gregorini 2006, Burns 2002). During the spring and fall months they spend approximately 8 hours, while in the summer about 12 hours. During the winter most of the cattle are fed hay. Cattle may graze 12, or more, hours during that time if forage is available. When cattle are not grazing, they are staying in the loafing area which is usually the riparian area or near water . In the spring, summer and fall they seek shade which is generally in the riparian areas (OCC 1999). While loafing they are ruminating and defecating. The average beef cow defecates 12 times per day at about 5 pounds per defecation (Larsen 1995). Since cattle may spend up to 16 hours in the loafing area or near hay feeding areas, there tends to be an accumulation of fecal material in those areas along with erosion of stream banks (Mosely 1998, Davies 2004 and Boles 1995). The Wadeable Streams Assessment (EPA 841-B-06-002) shows riparian disturbance within the IRW at 77 % (medium to highly disturbed rating).

Dairy cattle are maintained in a similar pasture setting as beef cattle but most have available more annual seeded forages. The lactating cows (2/3 of the adult herd) are taken to the milk barn at least 2 times per day where they wait in line for milking. During the wait period defecation occurs, as well as, during the roughage feeding period post milking. That manure is stacked and applied to the land 2 to 3 times per year. Between milking periods the cows graze or loaf in the riparian areas as do beef cows. The dry cows (non-lactating) and heifers are kept on separate pastures from lactating and are treated much like beef cattle.

Swine are reared in total confinement buildings and the manure and urine along with excess water and spilled feed is collected in a lagoon. The contents of the lagoon undergo both aerobic and anaerobic fermentation resulting in loss of some of the solid components as gases. The microbial population changes drastically to meet the available oxygen. The lagoon effluent is spread on the pastures at least 2 times per year. Both farrow-to-finish and grow/finish facilities exist in the IRW. The 2002 census data showed that approximately 165,976 swine were present or marketed during that year (Appendix A, Table A-B).

Approximately 1,400 farms reported more than 8,000 horses in inventory (Appendix A, Table A-B). Some of those farms also have cattle. Horses are generally left to graze freely on pastures similar to cattle pastures and loaf as they choose-near shade and water. In some instances horses are kept in dry-lot settings where the loafing occurs in the shade of a barn. The accumulated manure and bedding in those cases is applied to the pastures as fertilizer. The latter case represents the minority (personal interviews). Horses do not always get reported since many owners of small acreages often have horses but do not recognize them as farm animals. The estimate above is considered conservative for the IRW.

Sheep and lambs reported were on 78 farms. About 1,900 were recorded in the IRW (Appendix A, Table A-B). Sheep pastures are more likely to have legumes as a dominant plant. The sheep are housed in the evenings and during the lambing period to avoid predator attacks. Manure accumulates in the holding areas where it is ultimately collected and spread on the pastures.

Many IRW wildlife species are found on the farms but they tend to spend a disproportionate amount of time in the riparian areas. Deer and wild turkeys forage on pastures and crops near the riparian areas then loaf in the more secluded wooded areas. Using harvest data the whitetail deer population in the IRW is estimated to be 29,400 and wild turkeys at 3,564. Wild geese and ducks visit the watershed during 5 months of the year. Head-day estimates were made on the basis of refuge and central flyway populations-128,000 goose days and 167,900 duck days were estimated (Appendix A, Table A-D). Numerous other wildlife species exist in or visit the IRW (Appendix J).

Nurseries and truck farming operations require liberal amounts of added nutrients for sustained production. Most of those facilities are on the better soil types near the streams where sedimentation has occurred to produce deeper soil layers with more silt and organic material. Irrigation is also required as needed resulting in more potential run-off during rain events.

Bacteria and Nutrient Access to Streams (Opinions 9 through 12)

All production animals, farming enterprises, human waste disposal, human activity, wildlife and numerous other sources contribute nutrients and/or bacteria to the IRW which may, or may not, contribute similarly to the streams and lakes. Fecal bacteria are produced in abundance by all animal species and reside in the wet manure until such time that they may be destroyed or transported via rain water or by direct application to flowing streams (Davies-Colley 2004, Larsen 2005, Soupir et al. 2003, Hall 2007, Gray 1983 and Mundt 1962). As animal manures dry and/or become exposed to sunlight the bacterial load diminishes resulting in less available bacteria for transport (Fujoika 1982, Sinton 2007, Meays 2005, Wang 2004, Almashriq 2008 and Berrang 2005).

Beef cattle, dairy cattle, horses and wildlife have access to streams offering the opportunity for direct deposit of manure while poultry and swine do not have direct access. In the case of poultry some of the manure is applied (indirectly) to the agricultural properties at specific times during the plant production year **but not in the riparian areas**.

Total tons of wet manure, pounds of nutrients and *fecal coliforms* produced annually by livestock and some wildlife in the IRW are shown in Tables A-D and A-E of Appendix A. The wet tons and relative percentages of manure and *fecal coliforms* **produced** for each class of livestock and wildlife is shown below:

	Wet Manure Produced		Fecal *Coliform* X 10^{10} cfu/100ml	
	%	Tons	%	No.
Beef Cattle	56.10	1,870,847	80.06	838,655,521
Poultry	25.18	839,773	10.62	111,263,259
Swine	10.87	362,331	6.59	69,011,557
Milk Cows	4.63	154,296	2.47	25,835,666
Horses and Ponies	2.52	83,892	0.01	138,175
Whitetail Deer	0.64	21,421	0.05	535,528
Sheep and Lambs	0.04	1,409	0.13	1,408,694
Wild Turkeys	0.01	459	0.001	12,098
Geese	0.001	24	0.060	629,790
Ducks	0.001	18	0.004	40,800

Poultry, swine and some of dairy cattle manure is allowed to undergo fermentation (composting) and/or drying before it is applied to land (Ag Waste Management Handbook). Those processes alter the bacterial populations and weight for each. In the case of poultry, the manure is dried from 75 percent moisture to about 25 percent and some fermentation takes place as the litter is layered in the houses after each flock (Kelley 1994, Lu 2003 and Lovanh 2007). Likewise, litter with manure that is stored may undergo additional fermentation due to composting (Jeffrey 2001). Dairy manure produced near the milk barn is stacked where composting takes place. Swine manure in lagoons undergoes aerobic and anaerobic fermentation. Some of these manures are applied to the IRW at various times during the year (poultry-after de-caking in some cases and at total clean-out of the house, swine-pump out of lagoons one to two times per year and dairy cattle-two to three times per year).

The relative percentages of "wet manure" and *fecal coliforms* that are **deposited or available for application** would therefore be adjusted accordingly (Table A-A, Appendix A):

	Wet Manure Deposited or Available for Application		*Fecal Coliforms* Deposited or Available for Application	
	%	Tons	%	No.X 10^{10} cfu/100ml
Beef Cattle	72.41	1,870,847	87.99	838,655,521
Poultry*	11.42	295,114	5.84	55,631,629
Swine*	7.01	181,155	3.62	34,505,778
Milk Cows*	5.01	129,347	2.26	21,572,782
Horses	3.25	83,892	0.01	138,175
Whitetail Deer	0.83	21,421	0.06	535,528
Sheep and Lambs	0.05	1,409	0.15	1,408,694
Wild Turkeys	0.02	459	0.00	12,098
Geese and Ducks	0.00	43	0.07	670,580

*Some, or all, available for manual application as fertilizer. Poultry manure is shown as litter (24 % moisture for broiler, 34 % for turkey and 50 % for layers.)

The manure applied to agricultural fields after being harvested from respective poultry, swine or dairy cattle operations is spread with an applicator such that individual particles are further exposed to drying and sunlight thus further reducing the viable bacterial load. Poultry litter applied at the rate of two tons (4,000 pounds) per acre (43,560 square feet) would result in the application rate of 1.47 ounces per square foot.

Studies on bacterial survival after exposure to drying and sunlight have shown the depletion rate of various bacteria. Exposure to sunlight on membrane surfaces resulted in inactivation of 90 % of *fecal coliforms* within 15 minutes (Fujioka 1982). *Fecal streptococci* (*enterococci*) were likewise inactivated but at a slower rate. Harwood (2008) stated in The Preliminary Injunction testimony that bacteria exposed to direct sunlight would be killed within 2 hours.

A study involving beef cattle fecal pats showed that drying influenced the survival of bacteria but in most cases some of the bacteria were protected from sun due to crusting on the surface of the pat (Sinton 2007). The rate of depletion (by 90 %) was in the following order: *Campylobacter jejuni* (6.2 days), fecal *streptococci* (35 days), *Salmonella enterica* (38 days), *E. coli* (48 days) and *enterococci* (56 days).

Water samples collected (by the Oklahoma Department of Environmental Quality and plaintiff's consultants) from streams and other waters within the IRW were identified as having fecal indicator bacteria present. Due to the low relative number, degradation of bacteria in litter after drying and sunlight exposure and placement away from the riparian areas, poultry litter is an unlikely source of bacteria in streams within the IRW. To the contrary, proximity placement of manure near riparian areas by grazing animals and longevity of survival of bacteria in fecal pats makes for a more probable source.

Plaintiff's consultant Teaf has made calculation of *fecal coliform* production in the IRW. Those calculations were compared to that of Clay. Teaf's calculation methods were not clear but it appears that the calculations for livestock present in the IRW has under estimated cattle and over estimated poultry. His cattle calculations do not take into account all cattle present plus he has divided his estimate by 2. The comparison of animals in the IRW and relative percentage of *fecal coliforms* (FC) is shown:

	Teaf		Clay	
	Number	FC/day (%)	Number	FC/day (%)
Cattle	49,228	44.38	199,584	82.62
All Poultry	36.2 MM	41.09	150.8 MM	10.63
All Other LS	162,345	14.53	176,098	6.74

Plaintiff's consultants Engel, Alexander and Smith have calculated what they call a mass balance for phosphorus (P) in the IRW. In their estimates they focus on manure and other sources of P produced with the implication that all phosphorus produced winds up in the IRW with ultimate direct access to the streams and/or lakes. They do not account for livestock products sold other than beef calves. Likewise, they do not account for all crops or produce sold.

Their "mass balance" does not determine the fate and transport of P within the watershed. Because cattle, horses and wildlife have direct access to streams and/or riparian areas, the distribution of manure for those species tends to be more concentrated near the stream's edge or in the streams thus influencing the fate and transport of P in the IRW (OCC 1999). Poultry manure is applied outside the riparian areas. Estimates for cattle, horses and wildlife were based on estimates of sub- watersheds used by the Oklahoma Conservation Commission and other sources. Seventy-nine percent of the beef cattle and horses and 37 percent of the dairy cattle have access to the riparian areas (illustrated in Appendix K). The estimated manure that is deposited directly in the streams or in the riparian areas is shown in Appendix F. Approximately 28,800 tons of manure is deposited directly in the streams annually with an additional 975,000 tons deposited in the riparian areas (mostly from cattle). Approximately 40 percent of the manure and *fecal coliforms* produced by grazing animals and wildlife is deposited within the riparian areas. Livestock and wildlife also contribute to the erosion of the stream banks and riparian areas further influencing the transport of P along with other nutrients and bacteria into streams.

Engel has estimated that cattle contribute 6 percent of the total phosphorus entering the water bodies. He made those calculations through identification of pastures with GIS and using pasture sizes from ODAFF records. His estimates of total cattle using 2002 census data are similar to that calculated by Clay but he assumes only 55% of cattle have access to streams (Clay estimate is 79 %). However pasture size from ODAFF represents pastures that required a nutrient management plan for poultry litter application, typically 20 to 30 acres in size. Not all pastures have an annual measurement. For the years of 2005 through 2007 there was an average annual testing of 618 pastures in Oklahoma and 962 in Arkansas but there are nearly 3,500 cattle farms with multiple pastures for each farm. Likewise, the 585,000 acres of beef cattle farms includes at least 74,000 acres of woodland pasture which would not show up in the GIS survey as open area. In Appendix K the dendritic drainage pattern illustrating 1st and 2nd order streams within the IRW shows that there are few tracts of 160 acres, or greater that do not have a stream with its riparian area. Many of those would have 3rd order tributaries, mostly ephemeral, but cattle manure deposited there is more accessible for rainfall runoff into the perennial streams. Likewise it is important to note that cattle in these pastures tend to reside there year around offering long-term accumulative capacity. Regardless of where the phosphorus comes from originally, cattle tend to transport it toward the streams due to their tendency to loaf in shaded areas and or near water. Of the livestock and wildlife present in the watershed cattle excrete approximately 50 percent of the phosphorus (3,506 tons) with about 44 percent (1,500 tons) of that placed in or near the ephemeral and /or flowing streams where it has direct access during rainfall events. Obviously, not all of that will appear as measured P in the streams leading to lake Tenkiller but a considerably greater quantity than that estimated by Engel is likely to show up there. His estimate of 6 percent is based on studies in dairy cattle in New York state and beef cattle in the foothills of Colorado. Neither are representative of the weather and/or environmental conditions of the IRW. Loafing near shade and water is a more common occurrence with beef cattle in the IRW (especially those that graze on endophyte-infected fescue). In the beef cattle study referred to by Engel (Gary 1983) 8 percent of the fecal matter was observed to have been deposited directly into the streams—Engel stated that 8 percent was deposited in or within 10 meters and he made his calculations on that basis. With 8 percent of the fecal matter and P deposited directly into the streams using his 55% with direct access to streams, the amount of P placed in IRW streams would be 308,000 pounds (3,506 T of P X .55 X .08 X 2,000 lbs/T). This would be 60 % of the annual total measured (308,000 lbs / 500,000 lbs X 100) as reported by Engel. In the OCC Conservation Basin Management Plan Haraughty stated that "cattle act almost as a point source, depositing nutrients directly in the streams".

Poultry Litter Utilization in the IRW
(Opinions 13 through 17)

Annual poultry litter production in the IRW has been estimated by the plaintiff's consultants to be 354,000 tons (Engel and Fisher 2008). Dr. Dan Storm in his report to the Oklahoma Department of Environmental Quality in 2003 and 2006 estimated the production at 231,000 tons. The actual production is calculated to be somewhere in between those estimates.

Poultry litter contains the animal manure plus (or minus) wood shavings with all at about 25 % moisture (20 to 40 %). Defendants have provided a list of their active poultry houses (1,810) shown in Appendix I and BMPs, Inc. has provided the average amount of litter harvested from each broiler house where BMPs, Inc. collected it for export from the IRW in 2006 and 2007 (190 tons which includes de-cake material at 35% moisture—when all is adjusted to 25 % moisture = 170 tons). Using those calculations the total production would be 307,700 tons if all litter produced were assumed to have come from broiler houses. Using the Poultry Waste Management Handbook (NRAES-132) and 2002 data, the estimate is 312,033 tons.

From the 2002 census calculations using zip code data there were 603 poultry farms identified in the IRW (Appendix B). Using an average number of houses of 3 per farm (OCC Haraughty 1999, and OCC 2007) the total houses calculate to 1,809- a number very similar to that reported by defendants. The actual estimates based on 2002 agricultural census with adjustments for fermentation and drying reveals that litter potentially available for application in the IRW is about 295,000 tons (Table A-A, Appendix A). If that is adjusted for a confirmed amount of litter exported annually (Herron 2007 and 2008) the final amount available for application, carry-over or storage is about 225,000 tons. Using information obtained from Fisk 2004-2008 the amount of litter carried over into the 2nd year before a complete clean-out is estimated to be 8.0 percent (23,600 tons). The amount stored is estimated at 6.1 percent (18,000 tons). The annual litter production, carry-over, stored and export estimates are summarized below in tons:

Engel/Fisher	354, 000
Storm	231,000
Herron/Clay	307,700
NRAES-132/Clay	312,033
Clay 2002 Census	295,114
Carry-over	23,600
Stored	18,000
BMPs Export	70,000

From the perspective of manure **nutrients available for deposit or potential application to agricultural land**, the 2002 census data was used for calculations and is shown below in tons:

	Dry Mass	%	Nitrogen	Phosphorus[1]	Potassium
Beef Cattle	217,018	50.1	10,967	3,337	6,774
Poultry (litter) *	157,423**	36.4**	4,808**	2,411**	3,024**
Hogs and Pigs*	18,116	4.2	1,032	776	1,251
Milk Cows*	16,168	3.7	636	169	520
Horses and Ponies	18,456	4.3	494	117	411
Whitetail Deer	5,355	1.2	241	38	161
Sheep and Lambs	352	0.1	15	3	11
Wild Turkeys	117	0.03	6	2	2
Wild Geese and Ducks	12	0.00	.5	.2	.1

*Some, or all, is collected and manually applied. Poultry manure is applied as litter minus that exported but all other numbers represent manure.

**Based on Clay estimates but a range of values exist for each.

[1]Where phosphorus is used in this report it does not refer to elemental P in practical application. In soil, plant and animal life processes P exists in various oxygenated forms as in phosphate or orthophosphate.

Nutrient source of fertilizer for each of the farming enterprises is different. Wherever possible cattle enterprises use animal manures and/or supplement it with commercial inorganic fertilizer (Appendix E). Until recent years they were advised by their respective State Cooperative Extension Service to use animal manures based on nitrogen (N) content in that most soils have a large capacity to store the less mobile nutrients (P and K). As prevailing concern developed pertaining to nutrients in fresh waters the focus was turned to application of animal manures on the basis of P content rather than N content and then apply any additional N needed from commercial fertilizers. Today state laws are in effect that mandate that those who spread litter must collect samples for soil test phosphorus (STP) concentration. The STP along with other criteria is used to regulate poultry litter fertilizer application. The state of Oklahoma has adopted the US Department of Agriculture Natural Resources Conservation Service (USDA NRCS) Code 590 and the state of Arkansas has developed a phosphorus index including the guidelines of Code 590. The Oklahoma requirements prohibit application on IRW soils with STP above 300 pounds per acre while Arkansas requirements offer a sliding scale based on slope and alum treatment of litter. The Arkansas phosphorus index was developed in association with the USDA Agricultural Research Service.

In both states nutrient management plans (NMP) are required for each farming enterprise that chooses to use poultry litter as fertilizer. The NMP requires soil and litter nutrient testing so that appropriate amounts of a specific poultry litter will be applied to a specific farming property (Daniels 2004). To facilitate the development of NMPs both states have teamed with the NRCS and developed a list of qualified planners for farming enterprise managers to choose an appropriate advisor. To further assist poultry producers who do not have a need for some or all of their litter, a website has been developed to facilitate sales and transport to farmers outside the IRW. BMPs Inc. has been formed to arrange those collections and shipments. An additional transportation monetary incentive for farmers to use that poultry litter has been developed in Oklahoma (Title 68, Chapter 1, Article 2357.1) and Arkansas (Title XI, ANRC 138). Currently, at least 70,000 tons of poultry litter is shipped out of the IRW annually using those support entities (Herron 2006-8).

There are 4,482 farms in the IRW that were identified in the 2002 Agricultural Census and 3,364 were identified as beef cattle farms (75 %). One thousand two hundred fifty-five own properties greater than 160 acres in size and many lease additional properties. There are, however, about 11,007 property owners in the IRW who own 5 acres or more (Appendix H) leaving more than 50 percent of all property owners with little or no regulatory oversight.

The livestock farmers who also own poultry businesses have relied on the poultry litter as one of their sources of fertilizer for pastures or hay for several years (Cooperative Extension Service web site for AR counties in the IRW). In my experience most have followed the guidance of extension service personnel who in the 1950's and 60's informed those farmers of the expected concentration of nitrogen in poultry litter and the expected pasture production (personal communication). The farmers, in turn, applied the nitrogen in the form of poultry litter to maximize their pasture growth and cattle production.

Current soil tests are focused on those properties near poultry houses but many acres exist in the IRW where poultry litter has not been applied routinely. The 2005 through 2007 soil tests for the 5 county area of the IRW show that approximately 1,580 pasture land parcels were tested per year during the three year period (Johnson 2008). That is a comparatively small number since there are about 4,500 farms and most of those farms have multiple land parcels (3 or more) that would require testing of each to comply with a NMP to have litter applied. Total farm acreage available to have litter applied is at least 494,000 with about 200,000 to 225,000 tons of litter available. That represents less than 0.5 tons of litter per acre, annually.

Commercial inorganic fertilizer sales are shown in Appendix E. The source for this information was the Association of American Plant Control Officials who record sales data at the county level throughout the country, annually. This is further evidence that cattle farmers in the IRW do use a combination of fertilizer sources but have become more responsive to concerns about phosphorus fertilization.

Plaintiff's consultant Johnson has attempted to make a case that poultry litter should not be applied on land where the STP exceeds 65, however, the states of Oklahoma and Arkansas with the advice of the ARS, NRCS, state universities, and citizens have looked at appropriate application rates with various STP concentrations. They do not concur that 65 should serve as the limit. Those legislated limits were described above in a description of the Code 590 and the phosphorus index. The plaintiffs have not produced evidence that the agricultural producers of the IRW are not following those respective state regulations (Littlefield 2007).

Criticism of Concentrated Animal Feeding (Opinions 19- 20)

Plaintiff's consultants Lawrence, Olsen, Fisher, Teaf, Johnson and others have leveled criticism at poultry producers suggesting that they represent confined animal feeding operations (CAFO's) or AFO's which pose a serious threat to public health and the environment. Wherever possible in their reports they have referred to them as "industrial farms" and suggested that poultry litter is not fertilizer but is a waste requiring disposal rather than utilization. They have suggested that the fecal indicator bacteria (*coliforms, E. coli and enterococci*) in water in the IRW are from poultry litter and that those bacteria are indicators that poultry are the source of human pathogens thought to be present in the streams and waters of the IRW. Likewise, because poultry producers use antibiotics in their management programs, there are allegations that antibiotic resistant human pathogens may be there as well. Additionally, they point to hormones that have been measured in the parts per billion or parts per trillion concentrations suggesting that they too come from poultry and pose a threat to humans or wildlife.

Feeding, growing and harvesting of animals for food has been in existence as long as humans have been identified in civilizations. In this country the evolution of animal feeding has moved from personal ownership of animals as food to concentrated confinement businesses where a few people grow the meat, milk or egg-producing livestock for the many. As the per capita income rose in this country and citizens chose to move from the rural setting to the metropolitan setting, entrepreneurs who studied production agriculture were willing to meet the demand for those animal products by developing the confinement businesses. Concomitantly, the Agricultural Experiment Stations at the Land Grant Universities and the Cooperative Extension Services provided informational assistance for efficient production of all food animals. The information was implemented by those entrepreneurs so that today confinement animal feeding operations are widespread and food is produced at lowest cost. Poultry are among them. That evolution and development has not been without government oversight.

The US Congress passed the Clean Water Act (CWA) in 1972 to "restore and maintain the chemical, physical and biological integrity of the Nation's waters". The CWA provided the authority to the EPA and established a comprehensive program for implementing the act. Among its provisions it prohibits the discharge of pollutants from a point source to waters of the United States except as authorized by a NPDES (National Pollution Discharge Elimination System) permit. In 1976 CAFO (Confined Animal Feeding Operation) regulations were issued which provided the designation of which AFO's (Animal Feeding Operations) could be designated as CAFO's under the CWA. In 2003 CAFO rules were published in the *Federal Register* to clarify the requirements of AFO's and CAFO's. In general, poultry broiler operations that do not have liquid manure systems and have less than 125,000 bird capacity will be designated as AFO's but not as CAFO's (which require an NPDES permit). The AFO requirement includes obtaining a federal permit and the implementation of a nutrient management plan based on phosphorus rather than nitrogen (CAFO Fact Sheet Series #1-#20). State agencies that regulate agricultural enterprises have the authority to designate any feeding facility as an AFO or CAFO as they see fit.

To assist in the conservation of natural resources the NRCS (Natural Resources Conservation Service) offers advice, guidelines and financial assistance to livestock producers and farmers in the conduct of their business to insure that the resources and environment are protected. Likewise, the FDA Center for Veterinary Medicine regulates pharmaceuticals that are applied to poultry whether through the feed, water or by other routes. That is done through an approval process for marketing and sale of drugs and then enforcement of the label that provides specifications for use (Vaughn 2005).

As already described, the respective states have created and implemented additional guidance and regulations for poultry producers to follow in protection of the environment and the citizens. The poultry business does come under the EPA guidance of AFOs and CAFOs, the FDA and additional state regulations—it is highly regulated as are other confinement livestock operations.

Dr. Lawrence cites the PEW Charitable Trust report on "Industrial Farm Animal Production in America" (IFAP-2008) as his source of justification for labeling poultry production in the IRW as a source of aforementioned ills to the public and environment. If one examines the IFAP report carefully, it is clear that the contributors were strategically selected without including experts in animal production. The product was not at all balanced and only provided a biased view offered by the carefully selected contributors (References include Animal Agriculture Alliance Coalition, American Farm Bureau Federation et al., IFAP writing team members who withdrew from the project and Animal Agriculture Liaison Committee of the American Veterinary Medical Association). The IFAP writing team members who withdrew their names from inclusion in the report included 14 animal scientist and veterinarians who had initially agreed to participate in the project. Their manuscripts differed significantly from the conclusions that appeared in the final report (The draft of their report is attached in the list of references). Dr. Lawrence goes on to list classes of antibiotics used in the poultry business and the concern about antibiotic resistance "created" in antibiotics used to treat bacterial illnesses in humans. He cites no confirmed resistance in human pathogens to antibiotics used in poultry that has resulted in bacterial illness in humans within or outside the IRW. In fact, the AVMA has thoroughly examined the issue of antibiotic resistance in animal pathogens relative to diseases caused by similar pathogens in humans (Vogel 2008). They found after examining the National Antimicrobial Resistance Monitoring System (NARMS) data collected from humans with clinical disease that there has been a general reduction in resistance trends for *Salmonella spp. (non-Typhi), Salmonella typhimurium, Campylobacter spp., Enterococcus faecium and E. coli 0157.* Likewise in Denmark where antimicrobials have been restricted to therapeutic use only in livestock, the disease incidence and deaths of swine have increased by 25 % and antibiotic usage for therapeutic use has increased by 143 %. They went on to note that it is important that antibiotics be used to help prevent and curtail diseases in animals before they enter the food supply.

In the IRW indicator fecal source bacteria have been found with no evidence of specific resistance. Evidence has been provided, however, to show that poultry are the unlikely source of those bacteria. Most of the antibiotics used in poultry production in the IRW are for the control of coccidia protozoa (defendant ration formulations). Those antibiotics are not used in human medicine to treat diseases.

Olsen has made measurements for various animal hormones in water and feces but has provided no evidence of adverse effects. Likewise, he has been unable to characterize hormones as being of poultry source, or otherwise. Hormones are not at all used in the production of poultry whereas they are used in beef and dairy cattle production. When measuring animal hormones in waters of the IRW it is important to acknowledge that all the animals and birds present produce and excrete various steroid hormones in varying quantities depending on their stage of maturity and sexual cycle. Likewise, the effluent waters from Publicly Owned Treatment Works within and outside the IRW contain steroids in variable quantities (Galloway 2004 and Lorenzen 2004). Information has been provided to show that poultry are less likely to be a source of hormones for the waters of the IRW than other animals.

IV. APPENDICES (A through K)

V. MATERIALS AND INFORMATION RELIED UPON

1. State of Oklahoma Petition dated June 13, 2005. State of OK et al. v. Tyson Foods, Inc., et al. Case 05-CV-329-JOE-SAJ. In the US District Court for the Northern District of Oklahoma.

2. State of Oklahoma's Motion for Preliminary Injunction and Integrated Brief in Support thereof. In the U.S. District Court for the Northern District of Oklahoma. State of Oklahoma v. Tyson Foods, Inc., et al. Case No. 05-CV-329-GKF(SAJ).

3. Haraughty, S. Comprehensive Basin Management Plan for the Illinois River Basin in Oklahoma. Water Quality Division, Oklahoma Conservation Commission, May 1999.

4. Affidavit of Lowell Caneday, Ph. D. In the State of Oklahoma's Motion for Preliminary Injunction.

5. Affidavit of J. Berton Fisher, Ph.D. In the State of Oklahoma's Motion for Preliminary Injunction.

6. Affidavit of Christopher M. Teaf, Ph. D. In the Sate of Oklahoma's Motion for Preliminary Injunction.

7. Expert Report of Christopher M. Teaf, Ph.D. In the State of Oklahoma et al. v. Tyson Foods, Inc. et al.

8. Deposition of Christopher M. Teaf, Ph.D. In the State of Oklahoma et al. v. Tyson Foods, Inc. et al.

9. Affidavit of C. Robert Taylor, Ph. D. In the State of Oklahoma's Motion for Preliminary Injunction.

10. Expert Report of C. Robert Taylor, Ph.D. In the State of Oklahoma et al. v. Tyson Foods, Inc. et al.

11. Deposition of Ca-Maine Foods' Steve Storm. In State of Oklahoma et al. v. Tyson Foods, Inc., et al. In the U.S. District Court for the Northern District of Oklahoma. Case No. 05-CV-329-GKF(SAJ). Pp 1, 98-101.

12. Cargill, Inc.'s Supplemental Answers to Plaintiff's First Set of Interrogatories. In State Of Oklahoma et al. v. Tyson Foods, Inc. et al. In the U.S. District Court for the Northern District of Oklahoma. Case No. 05-CV-329-GKF(SAJ).

13. Affidavit of Bernard Engel, Ph.D. In the State of Oklahoma's Motion for Preliminary Injunction.

14. Expert Report of Bernard Engel, Ph.D. In the State of Oklahoma et al. v. Tyson Foods, Inc., et al.

15. Deposition of Bernard Engel, Ph.D. In the State of Oklahoma et al. v. Tyson Foods, Inc. et al.

16. Affidavit of Gordon V. Johnson, Ph.D. In the State of Oklahoma's Motion for Preliminary Injunction.

17. Expert Report of Gordon V. Johnson, Ph.D. In the State of Oklahoma et al. v. Tyson Foods, Inc. et al.

18, Deposition of Gordon V. Johnson, Ph.D. In the State of Oklahoma et al. v. Tyson Foods, Inc. et al.

19. Affidavit of Roger L. Olsen, Ph.D. In the State of Oklahoma's Motion for Preliminary Injunction.

20. Expert Report of Roger L. Olsen, Ph.D. In the State of Oklahoma et al. v. Tyson Foods, Inc. et al.

21. Deposition of Roger L. Olsen, Ph.D. In the State of Oklahoma v. Tyson Foods, Inc. et al.

22. Affidavit of Valerie J. Harwood, Ph.D. In the State of Oklahoma's Motion for Preliminary Injunction.

23. Affidavit of Robert S. Lawrence M.D. In the State of Oklahoma's Motion for Preliminary Injunction.

24. Expert Report of Robert S. Lawrence M.D. In the State of Oklahoma et al. v. Tyson Foods, Inc. et al.

25. Deposition of Robert S. Lawrence M.D. In the State of Oklahoma et al. v. Tyson Foods, Inc. et al.

26. Expert Report of Megan Smith. In the State of Oklahoma et al v. Tyson Foods, Inc. et al.

27 Deposition of Megan Smith. In the State of Oklahoma et al v. Tyson Foods, Inc. et al.

28. Expert Report of R.J. Stevenson. In the State of Oklahoma et al. v. Tyson Foods, Inc. et al.

29. Expert Report of GD Cooke and EB Welch. In the State of Oklahoma et al v. Tyson Foods, Inc. et al.

30. Deposition of DJ Parrish. In State of Oklahoma v. Tyson Foods, Inc. et al.

31. Depositon of J Littlefield. In State of Oklahoma v. Tyson Foods, Inc. et al.

32. Deposition of JB Fisher. In State of Oklahoma v. Tyson Foods, Inc. et al.

33. Deposition of A. Ford. In the State of Oklahoma v. Tyson Foods, Inc. et al.

34. Tisdale, SL and Nelson, WL. Soil Fertility-Past and Present. Chapter 1, Soil Fertility and Fertilizers . The MacMillan Company 1956.

35. Millar, CE et al. Fundamentals of Soil Science. Wiley & Sons, Inc. 1958.

36. Beaton, J. Efficient Fertilizer Use—A Historical Perspective. www. answers.com/efficientfertilizeruse

37. Manure. Answers.com. www.answers.com/topic/manure

38. History of Food Production. http://encyclopedias.families.com/food-production-history-of-1-3-efc.

39. Synthetic Fertilizer. BookRags.com. www.bookrags.com/sciences/sciencehistory/fertilizer-synthetic-woi.html

40. Poultry Waste Management Handbook. Natural Resource, Agriculture, and Engineering Service Cooperative Extension. Ithaca New York. NRAES-132. 1999.

41. Agricultural Waste Characteristics. Agricultural Waste Management Field Handbook Chapter 4. US Department of Agriculture Soil Conservation Service. 210-AWMFH, 4/92.

42. 2005 Agricultural Chemicals Manual, N.C. State U.

43. Rules Governing the Arkansas Poultry Feeding Operations Registration Program. Title XIX.

44. Rules Governing the Arkansas Soil Nutrient and Poultry Litter Application and Management Program. Title XXII Arkansas State Statutes and Regulations.

45. The Surplus Poultry Litter Removal Incentives Cost Share Program. Title XI ANRC 138.

46. Oklahoma Registered Poultry Feeding Operations Act. Title 2, Agriculture. Oklahoma Statutes.

47. Oklahoma Poultry Waste Applicators Certification Act. Title 2, Agriculture. Oklahoma Statutes.

48. Rules for Registered Poultry Feeding Operations and Registered Poultry Feeding Operations. Title 35 Chapter 17, Subchapters 5 and 7. State of Oklahoma Regulations.

49. Credit for Purchase and Transportation of Poultry Litter Title 68, Chapter 1, Article 2357.100.

50. Eucha-Spavinaw management Act. Title 2. Agriculture and Rules. Title 35, Chapter 17, Subchapter 11. State of Oklahoma Statutes and Regulations.

51. Everett, John. Reports of the Special Master. City of Tulsa, et al. v. Tyson Foods, Inc. et al. Case No. 01-CV-0900-CVE-PJC. 2005-0

52. Payne, J and Smolen, M. Poultry Waste Management Education Program. 2007 update.

53. Vest, L. Poultry Waste: Georgia's 50 million Dollar Forgotten Crop. www.thepoultrysite.com/FeaturedArticle/FATopic.asp?AREA=WasteOdour &Dis

54. Zhang, H., Hamilton, DW and Britton, JG. Using Poultry Litter as Fertilizer. OSU Extension Facts F-2246. Oklahoma State University Cooperative Extension Service.

55. Redmon, LA. Selecting Forages for Nutrient Recycling. Production Technology PT 96-36 volume 8, No. 36. Oklahoma State University Division of Agricultural Sciences and Natural Resources.

56. Hamilton, DW. Application rates for Broiler Litter Applied to Pastures and Hay Crops. OSU Extension 1995-1999.

57. Zhang, H. Animal Manure Can Raise Soil pH. OSU Production Technology 98-7, Volume 10 No. 7 1998.

58. Zhang, H. Poultry Litter Quality Criteria. OSU Production Technology 2002-24.

59. Zublena, JP. et al. Soil Facts: Poultry Manure as a Fertilizer Source. North Carolina Cooperative Extension Service. Publication AG-439-5, 1993-97.

60. Mullins, AG et al. Poultry Litter as a Fertilizer and Soil Amendment. Virginia Cooperative Extension, Publication No. 424-034. 2002.

61. Mitchell, CC et al. The Value and Use of Poultry Manures as Fertilizer. Alabama Cooperative Extension System, ANR-244. 1995.

62. Sainju, UM et al. Tillage, Cropping Systems and Nitrogen Fertilizer Source Effects on Soil Carbon Sequestration and Fractions. J. Environ. Qual. 37:880-888, 2007.

63. Troxel, TR. Natural and Organic Beef. U. of AR Cooperative Extension Service. www. uaex.edu.

64. Melroe, TA et al. Conventional, Natural, and Organic Beef Production and Consumption. S. Dakota S. U. Cooperative Extension. EX2059, 2007.

65. Kerr Center for Sustainable Agriculture, Directory of Agricultural Producers 2006.

66. Oklahoma Department of Agriculture. Organic Food Act and Rules. Title 2, 5-301-307, Administrative Code 35:30-21-24.

67. ODAFF 2008. Oklahoma Organic Producers and Processor's

68. Funston, RN et al. Grazing Behavior of Rangeland Beef Cattle Differing in Biological Type. J. Anim. Sci.:69(4), 1435-42, 1991.

69. Gregorini, P. Behavior and Daily Grazing Patterns of Cattle-A Review. Professional Animal Scientist June 2006.

70. Burns, JC et al. Grazing Behavior of Ruminants and Daily Performance from Warm-Season Grasses. Crop Science 42:873-881, 2002.

71. Moseley, JC et al. Guidelines for Managing Cattle Grazing in Riparian Areas to Protect Water Quality: Review of Research and Best Management Practices Policy. www.uidaho.edu/cfwr/pag/pag15es.html.

72. Boles, JC et al. Beef Cattle Management for Water Quality Protection in Arkansas. University of AR Cooperative Extension Service.

73. Larsen, RE. Manure Loading into Streams from Direct Fecal Deposits. Rangeland Watershed Program Fact Sheet No. 25. U. of CA Cooperative Ext. and USDA NRCS 1995.

74. Davies-Colley, RJ et al. Water Quality Impact of a Dairy Cow Herd Crossing a Stream. New Zealand Journal of Marine and Freshwater Research, 2004, Vol. 38:569-576.

75. EPA 841-B-06-002 Wadeable Streams Assessment: A Collaborative Survey of the Nation's Streams. Page 56, May 2006.

76. Wang, WL et al. Survival of Fecal Bacteria in Dairy Cow Manure. ASAE Vol. 47 (4) 1239-46, 2004.

77. Mundt, JO. Occurrence of Enterococci in Animals in a Wild Environment. Appl. Microbiol. 11: 136-140. 1962.

78. Soupir, M et al. Bacteria Release and Transport from Livestock Manure Applied to Pastureland. ASABE paper no. 032149, 2003 Annual Meeting.

79. Hall, KM et al. Assessing Alternative Fecal Coliform Direct Deposit Modeling Approaches. ASABE Proceedings of Meeting March 10-14, 2007.

80. Meays, CL et al. Survival of E. coli in Beef Cattle Fecal Pats Under Different Levels of Solar Exposure. Rangeland Ecology & Management vol. 58(3):279-83, 2005.

81. Sinton, WS et al. Survival of Indicator and Pathogenic Bacteria in Bovine Feces on Pasture. Appl. and Environ. Micro. Vol. 73(24): 7917-25, 2007.

82. Hoorman, JJ. Pathogenic Effects from Livestock Grazing Riparian Areas. Ohio State University Extension Fact Sheet LS-5-05.

83. Graczyk, TK et al. *Giradia sp*. Cysts and Infectious *Cryptosporidium parvum* Oocysts in the Feces of Migratory Canada Geese (*Branta canadensis*). Appl. and Environ. Micro. 64 (7): 2736-2738, 1998.

84. Almashriq et al. Solar Disinfection Studies in Drinking Water. http://almashriq.hiof.no/lebanon/600/610/614/solar-water/unesco/35-46.html

85. Berrang, ME et al. Use of Water spray and Extended Drying Time to Lower Bacterial Numbers on Soiled Flooring from Broiler Transport Coops. Poultry Sci. 84:1797-1801, 2005.

86. Fujioka, RS et al. Effect of Sunlight on Enumeration of Indicator Bacteria Under Field Conditions. Appl. and Envir. Micro. 44(2):395-401, 1982.

87. Kelly, TR et al. Fate of Selected Bacterial Pathogens and Indicators in Fractionated Poultry Litter during Storage. J. Appl. Poultry Res. 3:279-288, 1994.

88. Lu, J et al. Evaluation of Broiler Litter with Reference to the Microbial Composition as Assessed by Using 16S rRNA and Functional Gene Markers. Appl. and Eviron. Micro. 69(2): 901-08, 2003.

89. Jeffrey, JS et al. Inactivation of Bacteria in Stacked Poultry Litter. 50th Western Poultry Disease Conference Mar. 2001.

90. Lovanh, N et al. Spatial Shifts in Microbial Population Structure within Poultry Litter associated with Physicochemical Properties. Poultry Sci. 86: 1840-1849, 2007.

91. Fisk, Patrick. Arkansas Natural Resources Commission Reports on County Registration of Poultry Facilities 2004-2008.

92. OK Conservation Commission 2007. Poultry Litter Transport from the Illinois River Watershed (Oklahoma) to Non-Nutrient Limited Watersheds. FY 2002. Draft Report for EPA Grant C9-996100-10 Project 6.

93. Herron, S. Poultry Litter Exported from the IRW September 2006 through July 31, 2008.

94. Storm, D. Illinois River Upland and In-Stream Phosphorus Modeling. Submitted to Oklahoma Department of Environmental Quality 2003 and 2006.

95. Tetra Tech, Inc. West Fork White River, Muncie to Hamilton-Marion County Line TMDL for E. coli Bacteria. February 2, 2004.

96. Parsons et al. Canadian River TMDL, Oklahoma Department of Environmental Quality. 2006.

97. The Water Line Newsletter for the Lakes of Missouri Volunteer Program. Canada Goose Blessing or Bane? September 1997.

98. American Society of Agricultural Engineers. Manure Production and Characteristics. ASAE D384.1 Feb 03.

99. Daniels, MB et al. Nutrient Management Planning for Livestock Operations: An Overview. University of AR Cooperative Ext. Ser.

100. OK Conserv. Comm. Poultry Waste Produced and Applied in Conservation Districts by Certified Applicators. 2003 Annual Report.

101. OK Conser. Comm. Poultry Waste Produced and Applied in Conservation Districts by Certified Applicators. 2006 Annual Report.

102. Sweeten, J et al. A Brief History and Background of the EPA CAFO Rule: Fact Sheet # 1, CAFO Fact Sheet Series, July 2003.

103. Sheffield, R et al. What is Required in a Nutrient Management Plan: Fact Sheet #20, CAFO Fact Sheet Series, July 2003.

104. Vaughn, SD. Overview of the Animal Drug Approval Process. US Food and Drug Administration Center for Veterinary Medicine. 2005 ppt. presentation.

105. PEW Commission on Industrial Farm Animal Production (IFAP) 2008 (CD Rom).

106. Salman, M et al. Global Food Systems and Public Health: Production Methods and Animal Husbandry in the United States. 2008 (CD Rom).

107. Smith, KJ. Statement Regarding Pew Commission Recommendations for Animal Agriculture. Animal Agriculture Alliance Coalition 2008.

108. American Farm Bureau Federation, Animal Health Institute, Murphy-Brown Farms, National Chicken Council, National Milk Producers Federation, National Pork Board and National Pork Producers Council. Animal Agriculture Deserves Balanced Discussion. 2008.

109. Vogel, L. Concerning Antimicrobial Resistance. Before the Senate Committee on Health, Education, Labor and Pensions, June 24, 2008.

110. Galloway, JM. Occurrence of Pharmaceuticals and Other Organic Wastewater Constituents in Selected Streams in Northern Arkansas, 2004. USGS Scientific Investigations Report 2005-5140.

111. Lorenzen, A et al. Survey of Hormone Activities in Municipal Boisolids and Animal Manures. Environ. Tox. 19:216-225, 2004.

112. Delmarva Poultry Industry, Inc. US Broiler Chicken Performance 1925-2000. Source: National Chicken Council.

113. Delmarva Poultry Industry, Inc. Average Live weight Per Broiler Chicken 1934-2003. Source: US Department of Agriculture February 2005.

114. Justice, R. Cherokee, Cookson, Sparrow Hawk and Tenkiller Wildlife Management Areas. Oklahoma Department of Wildlife Conservation. Brochures and personal communication.

115. About Lake Tenkiller Google Search. http://search.myway.com/search/GCcached.jhtml?pg=GGmain&ord=0&action=click&se

116. Heslebower, C. Sequoyah National Wildlife Refuge. Telephone communications and brochure from internet.

117. Lake Frances. http://www.okonline.com/frances.html

118. Waymire, J and Shaw, J. Oklahoma Department of Wildlife Conservation. Personal communication on deer and turkey populations.

119. Arkansas Game & Fish Commission. Weddington Wildlife Management Area and statistics on wildlife. www.agfc.com

120. Sharp, DE. Waterfowl Population Surveys. Central Flyway Databook 2007.

121. Bull, J. and Farrand, J. The Audubon Society Field guide to North American Birds.

122. Cornell Lab of Ornithology web presentation “All About Birds” www.birds.cornell.edu.

123. Clay, B. Livestock and Wildlife Estimates in the Illinois River Watershed along with Manure and Fecal Coliforms. CD Rom version of Appendices for Expert Report November 2008.

124. National Agricultural Statistics Service 2002 Census of Agriculture. www. agcensus.usda.gov

125. NASS May, 2008. Arkansas: Prices paid by Farmers and Ranchers.

126. State of OK et al v. Tyson Foods, Inc.,et al. Preliminary Injunction Hearing Transcript,Volume III. No. 05-CV-329-GKF-SAJ. In the US District Court for the Northern District of Oklahoma.

127. Tucker, B. OK State University. Department of Agronomy Professor Emeritus. Personal Communication.

128. Payne, J. OSU Area Extension Specialist. Personal Communication.

129. Burton, B. OSU Area Extension Specialist. Personal Communication.

130. Barnes, K. OSU Area Extension Specialist. Personal Communication.

131. Williams, R. County Extension Director, Cherokee County, OK. Personal Communication.

132. Green, M. County Extension Director, Adair County, OK. Personal Communication.

133. Seay, R. County Extension Director, Benton County, AR. Personal Communication.

134. Ware, DK. District Conservationist, NRCS. Tahlequah, OK. Personal Communication.

135. Gonzalez, J. County Extension Director, Washington, County, AR. Personal Communication.

136. Bagby, R. District Conservationist, NRCS. Stillwell, OK. Personal Communication.

137. University of Arkansas Cooperative Extension Service web page for counties. www.uaex.edu/Washington/agriculture/beef.htm

138. Fram, M. Oklahoma's Poultry Litter Transfer Program. Power point presentation for OSU Cooperative Extension Service.

139. Parrish, D. Frequently Asked Questions. Oklahoma's Poultry Waste Management Regulations. OK Dept. Ag. Food and Forestry and OSU Cooperative Extension Ser.

140. Oklahoma Litter Market. www.ok-littermarket.org/incentives.asp

141. Daniels, et al. Soil Phosphorus Variability in Pastures: Implications for Soil Sampling. U. of AR Cooperative Ext. Ser.

142. Ritz, CW et al. Poultry Litter Sampling. Cooperative Extension Service, Univ. of GA. www.pubs.caes.uga.edu/caespubs/pubcd/B1270.htm

143. Hutchison, ML et al. Effect of Length of Time before Incorporation on Survival of Pathogenic Bacteria Present in Livestock Wastes Applied to Agricultural Soil. Appl .Environ. Micro. 70 (9): 5111-5118, 2004.

144. Davis, RK et al. Escherichia Coli Survival in Mantled Karst Springs and Streams, Northwest Arkansas Ozarks, USA. J. Amer. Water Res. Assoc. 41(6): 1279-1287, 2005.

145. Historical Weather Data for Tahlequah, OK, Siloam Springs, AR and Prairie Grove, AR. www.weather.com

146. Armfelt, M. Technology in Agriculture-Yesterday, Today and Tomorrow. Power point presentation to Amer. Assoc. of Bovine Practitioners.

147. Storm, D. Deposition Transcript in the State of Oklahoma et al. v. Tyson Foods, Inc., et al. 2008.

148. Herron, S. Deposition Transcript in the State of Oklahoma et al. v. Tyson Foods, Inc., et al. 2008.

149. Brown, MD. Deposition Transcript in the State of Oklahoma et al. v. Tyson Foods, Inc., et al. 2008.

150. Edwards, DR, et al. Quality of Runoff from Fescuegrass Plots Treated with Poultry Litter and Inorganic Fertilizer. J. Environ. Qual. 23:579-584, 1994.

151. Franklin, DH et al. Fertilizer Source and Soil Aeration Effects on Runoff Volume and Quality. Soil Sci. Soc. Am. J. 70:84-89, 2005.

152. Gaudreau, JE et al. Response of Turf and Quality of Water Runoff to Manure and Fertilizer. J. of Environ. Qual. 31:1316-1322, 2002.

153. James, E. et al. Phosphorus Contributions from Pastured Dairy Cattle to Streams of the Cannonsville Watershed, New York. J. of Soil and Water Conserv. 62(1): 40-47, 2007.

154. Gary, HL, et al. Cattle Grazing Impact on Surface Water Quality in a Colorado Front Range Stream. J. of Soil and Water Conserv. March/April 1963: 124-128.

155. Photos of Cattle, Riparian areas and the IRW. 2006-2008.

156. Tyson Foods, Inc. Historical Complex Feed Formulas for Westville and Springdale Locations.

157. Miscellaneous references used in development of estimates along with selected calculations.

158. Personal Knowledge and Experience.

VI. QUALIFICATIONS

A Biographical Summary is attached below. My background includes livestock production, crop production, teaching, research, extension, pharmaceutical development, marketing and sales, consultation in soil, plant and animal sciences, regulatory affairs, legislative affairs, public health policy, oil and gas development and retail sales. As a veterinary toxicologist my endeavors have been focused on diagnosis, management and mitigation of incidental occurrences that affect the health of animals, people and the related environment. My training as an agronomist has provided the additional perspective for the application of science to the understanding of soil, plant, animal and human inter-relationships.

Pharmaceutical development has involved data gathering with a team of researchers for ultimate submission to the Center for Veterinary Medicine FDA and USDA for consideration in the approval process for new animal products. Several product candidates involving most of the domestic animal species have been researched and submitted for consideration. Many were approved and are marketed today.

All of that training and experience has come to play in this litigation brought by the State of Oklahoma against the poultry industry in the Illinois River Watershed.

BIOGRAPHICAL SUMMARY

Of

BILLY R. CLAY

B.S., M.S., D.V.M., DIPLOMATE

American Board of Veterinary Toxicology

3207 Timberlake Drive
Post Office Box 367
Stillwater, Oklahoma 74076-0367

brc123@hughes.net

405 377-1482 office
405 377-5237 facsimile
405 747-6414 cell

Personal

Born in rural Eastern Oklahoma to agrarian parents on 23 October 1942
Married to Maria Elena
Children: Two sons Stepchildren: one daughter and one son

Education

Diplomate	American Board of Veterinary Toxicology and completed the course requirements for a Ph.D. in crop physiology at Oklahoma State University	1975
D.V.M.	Oklahoma State University	1970
M. S.	Agronomy, Oklahoma State University	1966
B. S.	Agronomy, Oklahoma State University	1964

H. S. Diploma	Liberty Mounds High School, Mounds, OK	1960

Special Expertise

- Animal/Plant/Soil Interactions with emphasis on water quality
- Nutritional and Toxicological relationships in animals
- Agricultural production with a focus on plant and animal health
- Pharmaceutical development and Product Support

Employment/Work History

Veterinary, Environmental and Agronomic Consultant	1968-Present
Pharmacia/Upjohn Animal Health Technical Consultant	1977-2003
Smith Kline Animal Health Research Consultant	1973-1976
Oklahoma State University	
Adjunct Professor, College of Veterinary Medicine	1986-Present
Assistant Professor, College of Veterinary Medicine and The Oklahoma Agricultural Experiment Station	1970-1976
Instructor, Department of Anatomy, OSU CVM	1967-1970
National Science Foundation Graduate Assistant Fellow, Department of Agronomy	1965-1966
Undergraduate Teaching Assistant, Department of Agronomy	1964
Oklahoma Sorghum Testing Program, Field Supervisor	1962-1966
Meller Brothers Custom Harvesting	1961
Ennis Dairy Farm, Mounds, OK, Assistant Manager	1959-1960
Stanford Ranch and Turkey Poultry Farm, Bixby, OK	1956-1959

Experience Summary

- Farming, Ranching, Poultry, Swine and Sheep
- Dairying with employee supervision
- Experimental design, layout, culture and performance testing of sorghums (including employee supervision)
- Agronomic research with sorghums, forages, peanuts and plant fungi
- Course design and teaching of agronomy, anatomy and toxicology courses to undergraduate, professional and graduate students
- Graduate student committees
- Diagnostic research and resolution of animal maladies
- Diagnostic service for veterinarians and the animal owning public
- Public speaking (professional and lay audiences)
- Research and development of animal pharmaceutical products
- Marketing and sale of veterinary pharmaceuticals
- Interaction and involvement with livestock and food commodity groups, including exportation
- International agricultural feasibility study of the Caribbean Common Market and the country of Belize
- County and State government; funding, administration of resources and maintenance of physical plant
- Case preparation, consultation and/or court testimony of litigated animal/plant/soil damage or loss disputes
- Forensic toxicology
- Oil and gas industry (mineral leasing, exploration, production, marketing and government regulations)
- Legislative liaison and lobbyist for the Oklahoma Veterinary Medical Association

- Corporate Board experience (Oil and gas, commodity exporting, retail food business, digital information management, hydrogen as an alternative fuel)

Honors and Awards

Undergraduate School

- Phi Eta Sigma Freshman Scholastic Honorary
- Schowalter Foundation Scholarship
- Consumers Cooperative Association Scholarship
- Alpha Zeta Agricultural Honorary Fraternity
- Phi Sigma Biological Science Honorary Fraternity
- Hi W. Staten Memorial Scholarship
- Ralston Purina Scholarship
- FarmHouse Fraternity, President
- Omicron Delta Kappa, All-University Men's Honorary
- Phi Kappa Phi Scholastic Honorary
- Who's Who on American Universities and Colleges
- Outstanding Senior Award in Alpha Zeta
- Outstanding Senior Award in Agronomy
- Top Ten Graduating Senior Award Oklahoma State University 1964

Graduate and Professional School

- National Science Foundation Teaching Fellow
- Board of Reagents Achievement Recognition
- Phi Zeta Honorary
- Student Chapter of AVMA; President and Convention Delegate
- Charter Delegate to the first National Student Conference to organize a National Association of Student Chapters of the AVMA
- Omega Tau Sigma, President

Professional

- Phi Zeta, President
- Honorary Lt. Governor State of Oklahoma
- Distinguished Teacher Award
- Who's Who in Veterinary Science and Medicine (two-time entry)
- Certificate of Appreciation from Payne County Officers Association
- Upjohn Distinguished Service award
- Pharmacia Achievement and Dedication Award
- Inc. 500 Individual Achievement, America's Fastest Growing Companies, Hideaway 2 Inc. #260, 1998
- Oklahoma Veterinary Technicians Association Certificate of Appreciation
- OSU College of Veterinary Medicine Distinguished Alumnus Award
- Elected to the AVMA Council on Public Health and Regulatory Veterinary Medicine
- Elected to the AVMA Animal Agriculture Liaison Committee
- Elected to the AVMA Committee on Environmental Issues
- Elected as the AVMA representative to the OIE (World Health Organization for Animals)
- Elected as the AVMA candidate to EPA Advisory Committee
- Oklahoma Veterinary Medical Association's Distinguished Service Award
- Oklahoma Veterinary Medical Association President's Award

Professional Society Memberships

- American Veterinary Medical Association
- American Academy of Veterinary and Comparative Toxicology, Fellow
- American Board of Veterinary Toxicology, Diplomate, Regent and Committee Chairman
- Academy of Veterinary Consultants
- American Association of Bovine Practitioners
- Oklahoma Veterinary Medical Association, Vice President, President-Elect, President, Manpower and Legislative Committees Chairman and past advertising manager for the JOVMA
- Council for Agricultural Science and Technology
- Plains Nutrition Council
- American Society of Agronomy
- Crop Science Society of America
- Soil Science Society of America
- Oklahoma Native Plant Society

Membership in Other Organizations and Activities

- Farm House Fraternity Alumni Board of Directors, Past Chairman and Current Chapter Advisor
- As a Veterinary Student Led the Establishment of a Self-Directed Honor Code for the OSU College of Veterinary Medicine Student Body
- As a Faculty Member Developed and Administered a Student Advisement System for the College of Veterinary Medicine Student Body and Faculty
- Served on the Planning Committee for the Establishment of a New Teaching Hospital for the OSU College of Veterinary Medicine
- Served as Chairman of the Planning Committee for the Development of a New Library for the OSU College of Veterinary Medicine
- Oklahoma State University Alumni Association, Past Director and Life Member
- OSU College of Veterinary Medicine Alumni Society, Class Representative and Past President (two terms)
- Oklahoma Animal Disease Diagnostic Laboratory Advisory Board, Past Chairman (three terms) and member of the selection committee for the Laboratory Director.
- OSU College of Veterinary Medicine Student Selection Group for 2002
- National Cattlemen's Beef Association
- Oklahoma Cattlemen's Association, Committee Member
- Texas Cattle Feeders Association.
- Plains Nutrition Council
- Past Advisor on research to Kansas State University's Department of Pathobiology
- Member of Council on Citizens Against Government Waste

Public and Private Endeavors

- Served on development, marketing and product support teams for MGA®, Lutalyse®, Naxcel®, Excenel®, Adspec®, Antirobe®, Mitaban®, Lincomix®, Albadry Plus®, Pirsue®, and Excede®
- County Government: Excise/Equalization Board, Past Chairman
Board of Tax Roll Corrections, member

- ITAR Energy Corporation: Board of Directors and Treasurer (Mineral Holdings)
- Cimarron Valley Energy Corporation: Past Chairman, Board of Directors (Oil/Gas Production)
- American Agricultural Marketing Corporation: Past Chairman, Board of Directors (Agricultural Product Export)
- Hideaway 2 Inc.: Past Chairman, Board of Directors (Retail Pizza Chain)
- Pardalis, Inc.: Member, Board of Directors and consultant (Digital information management)
- Coastal Hydrogen, Inc.: Member, Board of Directors (Experimental production of hydrogen)
- Consultant for law firms, insurance companies, industrial firms, animal and land owners, etc. concerning property damages or losses

Publications and Presentations

Numerous articles, reports and publications have been authored but most are proprietary in nature.

Presentations have been delivered for a variety of audiences with professional continuing education as the typical format.

VII. COURT CASES WITHIN THE PAST FOUR YEARS IN WHICH TESTIMIONY OR DEPOSITIONS WERE GIVEN

Cecil Dougherty and Pete Glasscock v. LeMaster Livestock, Inc. and Eastern Livestock Co., LLC In US district Court Northern District of TX, Amarillo Division. CA No. 2-0-5CV-023J.

Clifford Simmons and Sharon Simmons v. TEPPCO Crude Pipeline, L.P. Case No. CJ-03-251. In Dist. Ct. of Caddo County, OK.

Mary E. Green, et al. v. Alpharma, Inc., et al. Case No. CV-2003-2150-2. In the Circuit Court of Washington County, Arkansas.

Billy Ray Mainer et al. v. Fairfax Elevator Co. et al. Circuit Court of Franklin County AR. Case No. CV-2005-22-1.

Wordprotemps, Inc v. Post Petroleum Company et al. Case No. CV-06-152. In the District Court of McClain County State of Oklahoma.

Wyatt v. C-P Integrated Services, Inc. CJ-2004-399. In the District Court of McClain County State of Oklahoma.

DKMT Company v. Cimarron Transportation, LLC. CV-06-261, CJ-06-575. In the District Court of McClain County State of Oklahoma.